

The City of St. James A Case Study of Proactive Grid Maintenance and Community Resilience

Missouri Roadmap to Resilience Missouri Department of Natural Resources

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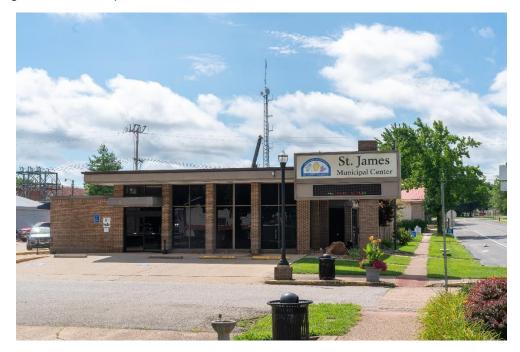
Purpose of the Case Study

Improving resilience of small-to-medium-size (SMSC) communities is increasingly important throughout the United States. SMSC are not only disproportionately impacted by chronic stresses and acute shocks, but often lack the resources to recover quickly compared to their more urban counterparts. Investing in resilience-focused initiatives within these communities is imperative to maintain community character and livability, especially for vulnerable populations. The *Roadmap to Resilience (Roadmap)* was developed by the Missouri Department of Natural Resources (MoDNR) with support from the United States Department of Energy (USDOE) as an implementable framework to address challenges and improve resilience within SMSC.

This case study presents an application of the *Roadmap* to the City of St. James, Missouri. Like many other SMSC, St. James is already engaged with planning to improve local energy services. The document demonstrates how the *Roadmap* actions and trackable metrics can be used to supplement the city's ongoing electrical grid modernization efforts to achieve improved outcomes. By leveraging the *Roadmap*, the city can improve the critical systems and infrastructure that support its residents. In this instance, the robust planning and resilience activities undertaken by St. James may be strengthened by



additional stakeholder and partner involvement and enhanced measurement of progress toward specific performance targets. By incorporating these elements of the *Roadmap* framework, St. James can obtain a better understanding of its customers and community priorities, as well as show progress toward their goals and drive performance.



St. James Municipal Center²

¹ For the purposes of this document, small-size communities are defined as rural areas, non-urban areas with a population of less than 2,500 people. Medium-size communities are defined as urban clusters, which are urban areas with a population of 2,500 to 50,000 people. U.S. Census Bureau (2019). 2010 Census Urban and Rural Classification and Urban Area Criteria. September 04, 2020. census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural/2010-urban-rural.html.

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The Roadmap to Resilience

Resilience for Small-to Medium-Sized Communities:

The ability of communities to withstand, adapt to and reduce the impact of acute shocks and chronic stresses while preserving and improving their unique characters, sense of community and livability.

The *Roadmap* was released in 2020 and is the culmination of a two-year project funded by the U.S. Department of Energy. The document is intended to serve as a resource for SMSC in improving their resilience by providing a number of tools and resources. Resilience for SMSCs is the ability to withstand, adapt to and reduce the impact of acute shocks and chronic stresses while preserving and improving their unique characters, sense of community and livability. The *Roadmap* recognizes the unique challenges and strengths present in SMSCs and enables local leaders to take meaningful actions towards creating a more environmentally, socially and economically resilient future. As access

to affordable, reliable and resilient energy services is central to building resilient SMSCs, the *Roadmap* focuses on improving energy systems through energy efficiency, grid modernization and renewable resources to reduce critical load, increase redundancy, reduce energy burden and harden infrastructure.

An SMSC-centric approach was used to develop the Roadmap, supported by local insights, leading resilience practices and expert research. A stakeholder engagement process served as the foundation that included workshops focused on energy-related topics such as energy and critical facilities infrastructure, economic development and growth, resilient community operations and energy burden. Engaged stakeholders included local government representatives, local businesses, electric utilities, academic institutions and technical

Chronic Stress:

Persistent, long-term issues or hardships that weaken a community's social, economic and environmental fabric and exacerbate outcomes to acute shocks. Examples include:

- Declining population
- Lack of access to healthcare
- Energy burden

Acute Shock:

Sudden, high intensity events that pose a direct threat to a community. Examples include:

- Floods
- Pandemics
- Extreme heat

stakeholders among others. Findings from local insights and an inventory study of baseline assets and practices were analyzed, synthesized and expanded upon to develop the *Roadmap* as well as metrics to track resilience progress.

The tools included in the final *Roadmap* feature guidance on stakeholder engagement, developing partnerships, accessing funding opportunities and defining metrics to measure success. The *Roadmap* provides a scalable approach for many SMSC to apply in their hometowns to increase resilience.

Resilience Vision:

Resilient SMSC are equipped with energy resources to thrive environmentally, socially and economically in the face of chronic stresses and acute shocks.

The development process of the *Roadmap* and its vision included a partnership with three Missouri communities, the Cities of St. James, Rolla and Stockton. These cities provided invaluable context, guidance and feedback throughout the progression of the tools and leading practices. To demonstrate application of the *Roadmap*'s scalable resilience planning tools, case studies for two of these cities

have been developed. These case studies use local context, data, resources and priorities to guide St. James and Rolla in their pursuit of reaching the Resilience Vision.

4 Phases of Resilience Planning

The *Roadmap* presents four foundational phases of resilience planning, which are supported by six guiding actions (see **Figure 1**). The guiding actions serve as actionable building blocks for communities to launch their resilience planning efforts through each phase. All of the phases and actions are guided by overarching concepts of transparency and inclusivity to build local support and comprehensively identify and address community priorities.

The four phases of resilience planning are: 1) assess; 2) envision; 3) implement; and 4) evaluate. The phases are intended to be successive and followed in the order in which they are presented.

Assess – Defining critical areas and examining existing conditions.

In this phase, communities define their resilience objectives and goals as well as identify resilience threats and stressors. It is critical to have a variety of stakeholders involved in this phase because of the value of having comprehensive and cross-sectoral representation. Additionally, a baseline assessment of existing energy assets and conditions is outlined to serve as a foundation for resilience-building efforts. Examples of assessment considerations include existing community energy burden, utility structure and distributed energy resources.

Envision – Collectively set resilience goals and quantitative targets.

Communities use the baseline conditions identified in the "Assess" phase to envision actionable targets that can be achieved through implementable measures. Feedback and approval from stakeholders and local authorities is solicited as needed in order to refine and finalize energy targets and goals.

Implement - Engage participants and integrate solutions.

Communities work with key stakeholders to define clear, actionable steps to implement initiatives that accomplish the targets set in the "Envision" phase. This will include developing partnerships and timelines, as well as considering funding sources to implement effective initiatives.

Evaluate – Evaluate potential impacts and benefits of investments and initiatives.

Communities monitor strategies and progress on critical areas, report findings and adjust planning and implementation as needed to support ongoing monitoring of metrics and goals.

6 Actions of Resilience Planning

Stakeholder Engagement – Engage stakeholders early in the resilience planning process.

Stakeholders should be engaged to articulate priorities, assess baseline conditions, refine goals and assist in developing implementation strategies. Successful stakeholder engagement can increase the potential for long-term support and the chances for success.

Conduct Baseline Analysis – Conduct a thorough evaluation of existing conditions.

A thorough assessment of existing structures, barriers, systems, assets, initiatives and partnerships can be used to identify areas of opportunity that meet community needs and leverage existing strengths.

Leverage Partners and Assets - Convene skills, resources and perspectives.

Leveraging available resources, partners and assets can aid in mitigating critical gaps in funding and expertise, as well as provide a number of additional co-benefits.

Identify Innovative Funding Sources – Offset resilience initiative costs.

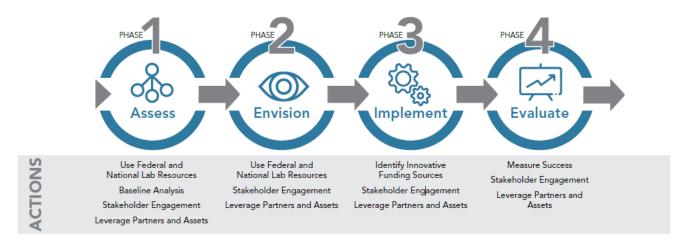
SMSC often face increased funding barriers and leveraging funding sources can play a critical role in determining whether plans can be implemented.

Use Federal and National Lab Resources – Support projects and initiatives.

Federal agencies and national laboratories, such as USDOE, Federal Emergency Management Agency (FEMA) and the Environmental Protection Agency (EPA) provide several quantitative and qualitative tools that can be leveraged for resilience planning and support projects.

Measure Successes – Define metrics and performance indicators early in resilience planning.Consistent measures to monitor progress enable communities to effectively demonstrate progress and accountability, promote continuous improvement and make forward-looking decisions and investments.

Figure 1 Roadmap Framework



St. James Background

The City of St. James is located on the northern edge of the Ozarks, lying along Interstate 44, approximately 100 miles southwest of St. Louis. It is known for its charm, local wineries and trout fishing at the neighboring Meramec Spring Park. The City is home to the Missouri Veterans Home, a nursing home for veterans and is close to the U.S. Army training installation, Ft. Leonard Wood. The City has a population of 4,100 residents of which 47% are above the age of 45.3 Significantly more of the community's residents are over 65 compared to the statewide average. Coupled with the Veterans Home presence, it continues to be an attractive community for retiring individuals.

Nearly half of the St. James population does not work. This is attributed to 7% of the population being unemployed and 40% not being in the workforce,⁴ both of which are higher than the statewide averages. Contrastingly, St. James is also home to a stable and diversified economic base of several major employers.

In reflection of community demographics, a significant portion of local critical infrastructure is focused on serving vulnerable populations, including veteran, elderly, low-income and youth residents as well as residents living with disabilities. Critical infrastructure ensures public health and safety, especially for vulnerable populations. Critical infrastructure in St. James is categorized by asset type in order of decreasing criticality: Essential Facilities; High Potential Loss Facilities; Transportation and Lifelines;

³ United States Census Bureau (2018). American Community Survey, 5-Year Data Profile 2014-2018. census.gov/programs-surveys/acs.

⁴ Those who do not meet the criteria of unemployed, but are not employed, are considered out of the workforce.

United States Bureau of Labor Statistics (2020). Labor Force Statistics from the Current Population Survey. bls.gov/cps/cps htgm.htm.

and Economic Assets. The most critical essential facilities include three medical facilities and the local St. James Police Department. The Missouri Veterans Home and the other local nursing home, the St. James Living Center, are both categorized in the next tier as High Potential Loss Facilities.⁵

All of the City's utilities, including its electric service, are provided by a municipally owned system. A lack of maintenance and repairs on the electric distribution system continues to result in mechanical failures and downed lines on a frequent basis. Even when the poles on the main sub-transmission line were replaced, the 1960's hardware and insulators were re-used, further exacerbating the already aging assets and sub-transmission lines that included 50-year old lines and transformers from the 1930s.

Existing Resilience Efforts

Following staffing changes in 2016, St. James began working to replace its aging electric infrastructure and engaging in proactive and protective grid maintenance. The decision stemmed from a past of deferred maintenance that had resulted in frequent system failures and downed lines. These planning efforts are vital to mitigating outages and ensuring that the city's critical operations are reliable and can serve the needs of its population, including its vulnerable communities.

System failures are only compounded by acute shocks and chronic stresses in SMSC, such as weather events and aging populations and can create long-lasting negative impacts. St. James has responded to this need by working with partners to develop a Hazard Mitigation Plan, increasing operational redundancy of the grid and integrating grid maintenance components into their Reliability Improvement Plan to address their aging infrastructure. The resulting Plan is focused on modernizing the city's infrastructure and taking a bold step forward on the road to resilience.

Grid modernization refers to changes in the existing power grid, typically with advanced communications and technology, to improve reliability, transmission and distribution of electric power. St. James' efforts represent a community's proactive investment to address aging infrastructure. It also demonstrates the ability of a SMSC to increase its resilience by advancing its hazard mitigation planning and infrastructure improvements. While the Reliability Improvement Plan is based upon forward-looking visioning, it does not include other components key to resilience planning, such as metrics with specific performance targets for tracking successes.

Application of the *Roadmap* is intended to build upon St. James' ongoing resilience efforts by expanding upon particular areas of importance, such as tracking metrics, potential partnerships, and funding sources. By including these components into their existing planning efforts, St. James will be well positioned to maintain progress on their goals and incorporate additional technologies that benefit them and their customer base, such as leveraged SCADA systems and energy efficiency measures. Application of the *Roadmap* framework can capture even more benefits, such as enhanced community resilience and leveraged community assets and planning.

Proactive Grid Maintenance and Connection to Resilience

Much of current grid modernization and advancement work focuses on introducing advanced technology, solar and other renewable energy resources. While such efforts are critical for environmental considerations, it should also be noted that not all communities are able to rapidly implement such initiatives, either due to resource constraints, competing community priorities, or other barriers. This is coupled with the fact that massive system-wide upgrades can be uncommon for SMSCs due to similar causes. However, proactive and consistent system maintenance, especially

⁵City of St. James, Missouri (2020). RFI Response: Multi-Jurisdictional Hazard Mitigation Plan Data Collection Questionnaire for Local Governments.

when coupled with energy efficiency measures, can be equally effective in improving system resilience and addressing multiple grid challenges by improving reliability and providing redundancy. It can also be an effective way to lay the foundation for advanced technologies or renewable energy considerations in the future.

As part of its grid repair and replacement plan, St. James aims to achieve fulfillment of work orders, continuing pole and transformer replacement programs and maintaining clear right of ways, easements and reconductor⁶ lines. Additional goals include becoming polychlorinated biphenyls (PCB) free, increasing the use of pad mount transformers, underground secondary electric and ensuring all newly installed pole and pad mount transformers are dual voltage. Finally, St. James also plans to rebuild their sub-transmission lines, establish a substation maintenance program, rebuild the distribution system from 4 kV to 7.2 kV, reimplement the use of SCADA, and evaluate expansion of a substation to streamline the system and reduce the load on an overloaded and aging substation. Achieving these goals of proactive grid maintenance would enable St. James to increase the reliability and resilience of critical infrastructure assets. Additionally, funds that would have been spent on maintaining and repairing aging infrastructure could be used to implement other needed system upgrades.

Specific opportunities for St. James to continue effective grid maintenance include focusing on:

- Proactive repair and replacement: Proactive repair and replacement is about pursuing a repair and replacement strategy that does not wait until an asset reaches a point of significant failure or damage before taking action. Rather, preventative actions are taken that include regular and routine maintenance and upgrades. Such actions typically save costs on maintenance as well as reduce disruption of the system due to repairs.
- **Ensuring redundancy:** Within the grid, redundancy refers to the duplication or 'back-up' of critical components and functions within the system to not only reduce the likelihood of system disruptions or outages, but also improve overall system performance. In the event of a failure, power is rerouted, until the repair is completed. Grid redundancies include measures such as upgrading major equipment, introducing redundant connections to other networks, redundant transitions and creating a redundant substation 'ring'. During repair and replacement, it is recommended to consistently evaluate the system to identify opportunities for increased redundancy.
- Leveraging AMI networks: Advanced Metering Infrastructure (AMI) refers to an integrated system of meters that can collect, measure and analyze data within the system. Such systems reduce the need for several labor-intensive business processes, such as manual meter reads, manual service turn-ons and service disconnections⁷. Most importantly, AMI systems can continuously communicate with the broader system providing a consistent flow of analytics and data that can support a number of operations. Information includes power outages, disconnect information, demand response and interval data. This can be routed to either troubleshoot or provide information used to support pricing and billing. In a similar but distinct vein, St. James has indicated an objective of reimplementing the use of SCADA within their system, providing another layer of advanced communications. AMI deployments offer many direct benefits to utilities by increasing electric distribution efficiency, reducing operating costs, facilitating peak load reductions through behavior change programs and improving revenue capture through smart meter accuracy and theft detection. There are also indirect benefits that can improve community livability such as enabling carbon emissions decreases, implementing dynamic pricing programs and enabling renewable generation integration.

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⁶ Reconductor refers to the act of replacing a cable, conductor, or wire, typically on a high-voltage transmission line, in order to improve current-carrying capabilities.

⁷ The City of St. James has the ability to do remote turn-on/turn-offs.

- Hardening infrastructure: From a grid perspective, hardening infrastructure entails approaching infrastructure decisions with the goal of reducing vulnerability to extreme events and disruptions. Hardening infrastructure is most frequently correlated with improved reliability and protecting critical assets. Examples of effective hardening strategies include replacing wooden poles with concrete, undergrounding power lines and installing additional poles to shorten the span between poles. A number of these initiatives are already within identified St. James objectives.

Introducing Energy Efficiency Measures: Energy efficiency measures can be one of the least expensive and fastest ways for utilities to source 'new' electricity. The levelized cost of energy (LCOE) is used to describe the lifetime cost of a resource per kWh. The LCOE resulting from energy efficiency costs \$0.02-0.04/kWh, in contrast to \$0.05-\$0.08/kWh and as much as \$0.015/kWh for natural gas and coal, respectively. Additionally, energy usage reductions from efficiency measures can now be used to meet other energy needs without having to source new energy. Energy efficiency measures can also help utilities manage times of high demand and reduce peak long, which not only makes it easier to provide reliable service to customers but can also reduce the need for system maintenance. Additionally, energy efficiency measures can reduce the energy burden of customers and the city itself. Decreasing the energy use in city facilities can result in a positive budget impact freeing up funds to better meet the needs of its citizens through city services and increasing the City's overall resilience.

These opportunities are closely linked to positive resilience outcomes, which include:

- Improved reliability: Reliability refers to the ability of the electric system to deliver expected service through both planned and unplanned events. Reliable systems are critical to ensuring that service is not disrupted, and customers do not experience outages and/or blackouts. Proactive maintenance efforts can be integrated within a culture of reliability by looking at root causes and prioritizing preventative repairs and upgrades. Implementation of predictive analytics and sensors coupled with energy efficiency measures can also be an opportunity to integrate advanced technology to achieve these goals.
- **Protecting critical assets:** Initiatives such as proactive repair and hardening infrastructure are closely connected with protecting critical assets. They reduce the likelihood that these assets will be damaged and/or disrupted. The reduced need for significant repair or replacement extends the effective life cycle of assets, further leveraging utility resources.
- Positive business impacts: Much of the outlined proactive grid maintenance efforts reduce unnecessary expenditures on inefficient processes and costly repairs of aging equipment. The money saved can be used to support incentive programs for customers, investments in technology used to provide improved and more reliable services and long-term projects to meet customer and community priorities. Positive economic impacts can also be realized through energy efficiency measures in city facilities. Savings realized through decreased energy consumption can be utilized for other city services to better meet the needs of the community members and other city priorities.
- Enabling improved emergency response: Effective emergency response plans are vital to
 ensuring that critical services are restored as quickly as possible. This includes ensuring that
 vulnerable populations are protected, of particular importance within St. James. Finally, effective
 responses also minimize damage inflicted by extreme events, reducing the need for significant
 recovery expenses and efforts.

Conduct Baseline Assessment

Conduct a thorough evaluation of existing conditions.

A thorough assessment of existing structures, barriers, systems, assets, initiatives and partnerships can be used to identify areas of opportunity that meet community needs and leverage existing strengths.

St. James Municipal Utility (SJMU) Electric System

The St. James electric system is comprised of an aging infrastructure that serves the area's commercial and residential customers. The significant load and lack of upgrades has created vulnerabilities within the system that St. James is working to address through proactive grid maintenance. The baseline assessment that was conducted compiled information about the St. James customer base, financing considerations and rate structures, staffing, management and maintenance needs, among other considerations.

Customer Base

The City of St. James provides electrical distribution services to 2,067 metered customers. As noted below, there are far more residential customers than other types, while commercial customers accounted for more than half of the utility's energy consumption and revenues during July of 2020. It should also be noted that all customers have advanced metering infrastructure (AMI).

Table 1 Customer Base

St. James Electric: June 25, 2020-July 25, 2020			
	Meters	kWh Used	Revenues
	2,067	5,197,323	\$514,713
Residential	82%	33%	38%
Commercial	14%	52%	50%
Industrial	0.2%	13%	12%
City Facilities	3%	2%	1%

Source: St. James Municipal Utilities RFI Response (2020)

The utility also provides dusk to dawn lights for 92 residential and 65 commercial customers. Five customers have residential solar installations which generate almost 2,200 kWh.

Rates and Charges

Rates and charges are set by the Municipal Utilities Board and approved by the City Council. Residential and commercial rates include a minimum monthly charge plus a usage rate per kWh of energy consumed, as depicted in Table 2 below. Industrial customers have no minimum monthly fee. They are charged a flat energy charge and a demand charge based on the energy they use.

Table 2 St. James Electric Rates and Charges

Power Usage Minimum Monthly Charge		Plus Rate/kWh
	Residential Service:	
Less than 50 kWh	\$10.22	NA
Next 250 kWh	NA	\$0.13012072
Next 1,200 kWh	NA	0.10222195

All over 1,500 kWh	NA	0.08623254	
Co	Commercial Service:		
Small Commercial (av	erage monthly usage o	f less than 10,000	
	kWh/month):		
Less than 100 kWh	\$18.40		
101-1,900 kWh	NA	\$0.12349677	
1901-8,000 kWh	NA	0.086355	
Over 8,000 kWh	NA	0.08987151	
Large Commercial (average monthly usage of more than 10,000			
kWh/month):			
Less than 2,000	\$255.55	NA	
kWh	\$255.55	IVA	
2,001-8,000 kWh	NA	\$0.086355	
Over 8,001 kWh	NA	0.08989	
Industrial Service:			
Energy Charge	NA	0.06506036	
Demand Rate	Rate NA	\$8.52 per	
	IVA	KWh	

Source: Official Statement, \$5,340,000, City of St. James, Missouri, General Obligation Refunding Bonds, Series 20168 (2016)

St. James Electric rates were last increased in 2016 by 1% as part of a series of increases: 6% in 2015, 3% in 2014 and 3% in 2013. Prior to that time, rates had not been increased since 2010.

In addition to the electricity rates and charges described above, the electric utility also collects a Payment in Lieu of Taxes (PILOT) from its customers. Established by city ordinance in 2009, this fee is a set percentage of gross revenues of the Municipal Utilities. PILOT collections are transferred from the Electric Fund to the City's General Fund and are a significant portion of the city's overall revenues. In Fiscal Year 2019, \$500,626 was transferred from the Electric Fund to the City's General Fund.

Billing occurs monthly and includes charges for electric, dusk to dawn lights, water, sewer, sanitation, trash pickup, natural gas and PILOT.

Debt

At the end of Fiscal Year 2019, the City had \$4.34 million in general obligation bonds outstanding for improvements to the electric system. The bonds were issued in 2011 to pay for the acquisition costs of the Phelps Substation and reconfiguration costs. The bonds are secured by the full faith and credit of the city but are paid with a portion of the revenues the collected from the electric system. The bonds will fully mature in 2030.

Staffing

Linemen: SJMU has three linemen, one fourth-year apprentice and two first-year apprentices. Linemen must complete a four-year journeyman course offered by the Missouri Public Utilities Alliance.

Official Statement, \$5,340,000, City of St. James, Missouri, General Obligation Bonds, Series 2016. emma.msrb.org/ER956799-ES615214-ES1010907.pdf

Utility Office Staff: An office manager and two utility clerks perform business functions of the Municipal Utilities Department as a whole, including those of the Electric Department.

Other Municipal Utility Staff: The Public Works Director is responsible for the operational management of all municipal utilities. Staff also include a mechanic, who is also certified to operate the digger truck, and utility technicians.

Contractors: Electric right-of-way and easement clearing contractors which must be Hot Work Certified to perform the function.

Critical Function Redundancies: The functions performed by linemen, office staff and clearing contractors are considered critical. Each function has standard operating procedures available should staff be unavailable.

The utility technician is trained to fill in for the utility clerks and there is a back up technician. Linemen are certified to provide right-of-way and easement trimming when needed.

Mutual Aid Agreements: Formal mutual aid agreements are in place with the City of Waynesville as well as with the Missouri Public Utilities Alliance, which can enlist the services of other member utilities. Mutual aid agreements provide for restoration services or equipment needs after a disaster or emergency. An informal agreement is also in place with the City of St. Robert.

Management

Utilities Board: The Municipal Utilities Board consists of four members which are appointed by the Mayor and confirmed by the City Council. The Board is responsible for setting the policy direction of the City's municipal utilities including the electric system, budget, bidding, construction, rates and fees.

Day-to-Day Oversight: The Public Works Director is responsible for the operational management of all infrastructure, including the electric service. The City Administrator oversees all city departments.

Electric Infrastructure

Overview: The utility's distribution system consists of approximately 1,548 poles, 586 pole mounted transformers, 89 pad mount transformers and four substations. There are approximately 48 miles of overhead circuits and three miles of underground circuits. Power is purchased through the Missouri Public Energy Pool (MoPEP) which is managed by the Missouri Joint Municipal Electric Utility Commission, one of the organizations under the umbrella of the Missouri Public Utility Alliance.

Metering: Unlike many smaller communities, 100% of St. James customers have AMI which collects energy consumption data and transfers it to the utility for billing purposes. The utility does not offer any demand response or energy efficiency programs.

Interconnection: The system is interconnected with one other electric utility, Ameren, which is the state's largest electric utility. This interconnection is at the Phelps Substation where SJMU takes power. The Phelps Substation was rehabbed in 2012 and has two, 26.7 MVA transformers.

Circuits and Substations: The system has three other substations. The Downtown Substation dates from the 1970s, has a 5/6.25 MVA transformer and serves three circuits. The New Parker Lane Substation went into service in 2012, has a 11.2/14 MVA transformer and serves two circuits. The third substation, the Industrial Park Substation, was built in the 1980s, has a 7,500/8,400 KVA transformer and serves two circuits.

Mapping: The utility has GIS mapping in place for sub-transmission and primary distribution facilities, but not the secondary system.

Infrastructure Vulnerabilities: While there is no formal vulnerability assessment, the utility believes the Downtown Substation is vulnerable due to its age and the significant load it carries. Typical life

cycle of a substation transformer is approximately 25-30 years. Utility staff have recently replaced its fans and are seeking quotes for inspection and replacement of reclosers and gauges. Other substations are also a concern due to age.

A major line received pole replacement in 2012; however, hardware and insulators originally installed in the 1960s were reused. Following an inventory of poles, most of which were set in 1962-1965, and transformers, it was determined that more than 600 poles were vulnerable to failure and needed to be replaced and that some transformers were originally installed in the 1930 and others contain PCBs.

Repair and Maintenance Needs

The city has a work order program to track work orders. When maintenance or repair is needed, it is entered into the system. Each work order is assigned an ID and information is included regarding the work type, location, date entered and length open. Recently the ability to track expenditures related to work orders has been added to the system. At the time the work order system was reviewed, 312 open work orders existed, of which more than 60% were related to poles. 210 work orders have been closed during 2020. The types and numbers of work orders can be seen below.

Table 3 2020 Work Orders

Work Order Type	Open Work Orders	Closed Work Orders
Replace/Install New Transmission Pole	111	0
Replace/Install New Pole (3 Phase)	53	32
Tree Trimming (Primary)	31	12
Other Utility Relocate	31	0
Replace/Install New Pole (Single)	11	4
Remove Pole	9	12
Install/Replace/Remove Street Light	9	21
Install Bollards	8	2
Misc. Task - Electric	6	50
Repair/Reconductor Power Lines (Single)	5	5
Repair/Reconductor Power Lines (3 Phase)	4	3
Install/Tighten Guy	3	2
Repair Yard	3	1
Power Outage (Secondary)	3	4
Install/Replace Overhead/Pad Mount Transformer (3 Phase)	3	2
Install/Replace Switch Gear	3	1
Remove Dusk to Dawn Light	3	2
Install/Replace Secondary Pole	2	7
Tree Trimming (Secondary)	2	2
Install/Replace Underground Primary (3 Phase)	2	2
Tree Trimming-Electric	2	0
Broken Poles	2	6
Leaning Poles	1	1
Install/Replace Underground Secondary Lines	1	3
Reconnect/Disconnect Electric	1	3
Install/Replace Transformer	1	3
Install/Replace Overhead/Pad Mount Transformer (Single)	1	6
New Service	1	5
Install/Replace Overhead Secondary Lines	0	4
Install/Remove Guy Anchor	0	3
Install/Replace Secondary Metering CTs	0	3
Install/Replace/Repair Electric Meter	0	3
Reprogram/Replace Router	0	3
Power Outage	0	1
Streetlight Outage	0	1
Utilities	0	1
Total	312	210

Source: St. James Municipal Utilities' Work Order Tracker (2020)

Reliability

SJMU primarily tracks its reliability performance using the American Public Power Association's (APPA) eReliability Tracker, although no specific performance targets were noted. Power outage information entered in the eReliability Tracker is analyzed and performance measures are reported. Performance measures reported for 2019 include:

- System Average Interruption Duration Index (SAIDI): 298.01 minutes.
 - SAIDI is the total duration of outages, in minutes, for the average system customer. It is calculated by dividing the total number of customer-minutes of interruption by the total number of customers served.
 - The SAIDI of 298.01 minutes is higher than the recorded average SAIDI of 75.23 minutes for the region and the average of 152.68 for similarly sized utilities.⁹
- System Average Interruption Frequency Index (SAIFI): 2.54 interruptions.
 - SAIFI is the average number of times a customer will experience an outage. SAIFI is calculated by dividing the total customer interruptions by the number of customers.
 - The SAIFI value of 2.54 is higher than the recorded average SAIFI of 0.97 minutes for the region and the average of 1.29 for similarly sized utilities.¹⁰
- Customer Average Interruption Duration Index (CAIDI): 117.28 minutes.
 - CAIDI is the average duration, in minutes, of outages for those experiencing an outage.
 CAIDI is equal to the total duration of sustained interruptions by the total number of interruptions.
 - The CAIDI value of 117.28 minutes is higher than the recorded average CAIDI of 99.62 for the region, but lower than the 345.80 for similarly sized utilities.¹¹
- Average Service Availability Index (ASAI): 99.9432 percent.
 - ASAI is ratio of customer hours service is available to the total customer hours of service demanded and is calculated by dividing the total hours service is available by the total hours demanded by customers.
 - The recorded ASAI value is in accordance with the regional and similar sized utilities' average.

SJMU is tracking higher than the regional average on a number of key reliability performance measures. Many of these measures can be improved with introduction of energy efficiency measures and continued maintenance on the system.

The Utility also tracks the number of outages per year. As can be seen from Figure 2, outages decreased by 15% between 2016 and 2019 and are on track to drop dramatically in 2020. This decrease can be attributed, at least in part, to the continued proactive maintenance of the system.

McPherson Board of Public Utilities (2019). *Annual Benchmarking Report: eReliability Tracker*. Average mcphersonpower.com/wp-content/uploads/2020/04/2019-APPA-Annual-Benchmarking-Report-eReliability-Tracker-002.pdf.

⁹ SAIDI for all utilities that use the eReliability Tracker in Region 3.

¹⁰ Average SAIFI for all utilities that use the eReliability Tracker in Region 3.

McPherson Board of Public Utilities (2019). *Annual Benchmarking Report: eReliability Tracker*. Average mcphersonpower.com/wp-content/uploads/2020/04/2019-APPA-Annual-Benchmarking-Report-eReliability-Tracker-002.pdf.

¹¹ Average CAIDI for all utilities that use the eReliability Tracker in Region 3.

McPherson Board of Public Utilities (2019). *Annual Benchmarking Report: eReliability Tracker*. Average mcphersonpower.com/wp-content/uploads/2020/04/2019-APPA-Annual-Benchmarking-Report-eReliability-Tracker-002.pdf.

25
20
15
10
2016
2017
2018
2019
2020

Figure 2 Power Outages 2016-2020

Source: St. James Municipal Utilities RFI Response (2020)

Reliability Improvement Plan

Prior to 2016, St. James did not routinely perform proactive maintenance, repair or replacement on its electric system. When equipment, poles or other items broke, they were fixed, but routine maintenance and replacement of distribution system components was neglected as was right-of-way clearing and tree trimming. This resulted in frequent system outages.

Since that time, the city has implemented a number of measures to maintain, repair and replace electric grid components that are threats to system reliability. It has cataloged work orders, as described above, and prioritized maintenance activities based upon impact to reliability. Additionally, SJMU has committed to invest an amount equal to its depreciation expense, approximately \$300,000, in proactive grid maintenance and modernization each year. The utility is considering setting aside a portion of those funds annually to build a reserve for future major expenditures, such as substation rebuilds.

The current goals of the Reliability Improvement Plan are to:

- Continue working through open work orders
- Pole and transformer replacement
- Reconductor lines where needed
- Electric right-of-way and easement clearing and maintenance
- Establish a scheduled substation maintenance program
- Strive to be PCB free
- Increase usage of pad mount transformers and underground secondary electric with meters located on pedestal
- New pole and pad mount transformer installs shall be dual voltage
- Reimplement use of SCADA system¹²

These goals should lead to increased reliability, and, as is demonstrated in the next section, St. James is effectively implementing the plan; however, it has not connected implementation to specific,

¹² The system was initially implemented when the City bought the Phelps substation. Although hooked up, it was never used due to a lack of initial interest.

measurable reliability performance targets such as decreasing the number or duration of outage events and increasing overall efficiency of the system. As such there are opportunities to supplement the Plan with objectives from the *Roadmap* including developing metrics with specific performance targets, identifying funding sources, building partnerships and introducing energy efficiency measures.

Plan Progress

The utility's Reliability Improvement Plan is based upon making improvements that have the greatest reliability impact based upon funds available. For example, given the age and number of poles needing replacement, pole replacement is a key component of the Plan. As shown in Figure 3, these efforts have accelerated since implementation of the plan and are on track during the first eight months of 2020 to continue that trend. In the spring of 2021, the focus of these efforts will be on the main circuit poles, three-phase distribution (non-carrying) poles and then secondary line poles.

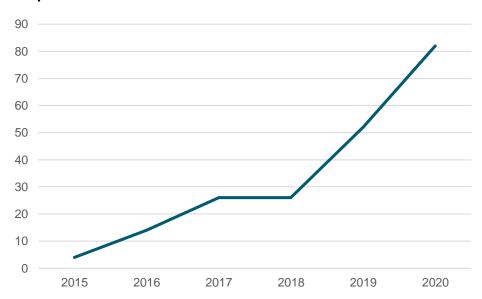


Figure 3 Poles Replaced 2015-2020

Source: St. James Municipal Utilities RFI Response (2020)

Reliability Improvement Plan activities also include tree trimming and vegetation management along rights-of-way and easements to decrease outages due to fallen trees or branches. Utilizing both utility employees and a private contractor, SJMU has closed almost 50 primary line tree trimming work orders since 2017, with almost half of those occurring in 2019. These work orders include individual locations as well as entire right-of-way easements.

Hazard Mitigation Planning

St. James is located within Phelps County, and participates in the Phelps County Multi-Jurisdictional Hazard Mitigation Plan. Plan development is coordinated by the Meramec Regional Planning Commission and covers all cities and school districts in Phelps County. The Plan is not specific to individual facilities such as the St. James electric grid, but contains general information relating to natural hazards which can occur in Phelps County and its hazard prone areas. The hazards addressed are shown in Table 4. The original plan was developed in 2004 and has been updated three times, most recently in 2016. The 2021 update is currently in progress.

The goals of the plan are to:

- Reduce risks and vulnerabilities of those in hazard prone areas.
- Reduce impact of natural disasters on property, infrastructure and the local economy.
- Promote programs to increase knowledge and awareness about hazards, vulnerability and mitigation alternatives.
- Strengthen communication and coordination.
- Establish priorities for reducing risk.
- Secure resources for investment in mitigation.

The plan sets forth a list of critical/essential facilities and infrastructure, as well as major employers, by jurisdiction. Examples of these assets include facilities for healthcare, emergency response, government operations, education, childcare, nursing homes, water and sewer facilities and transportation infrastructure. St. James has 42 such assets listed. The plan identified the hazards shown in Table 4.

Table 4 Phelps County Natural Hazard Probability and Vulnerability Ratings

	Probability	Vulnerability Ratings
Dam Failure	NDA	NDA
Drought	20%	L-M
Earthquake	1%	NDA
Extreme Heat	69%	L-M
Fires	100%	M-H
Flooding	85%	L-M
Land Subsidence/Sinkholes	NDA	NDA
Thunderstorm: Heavy Rain/	35%	М
High Winds/Lighting/Hail	33%	IVI
Tornado	41%	Н
Severe Winter Weather/		I NA
Snow/Ice/Severe Cold	81.82%	L-M
Vulnerability Rating Key:		
L = Low, M = Medium, H = High, NDA = No Data Available		

Source: Phelps County Multi-Jurisdiction Natural Hazard Mitigation Plan, Meramec Regional Planning Commission (2016)

The plan provides a profile for each hazard discussing the probability of each in Phelps County. While many of the hazards could impact the St. James electric system, the profile of severe winter weather events was tied specifically to power lines and equipment. It was noted that Phelps County averages between nine and 12 hours of freezing rain per year and that overhead lines and infrastructure is vulnerable to these events. Damage can occur due to ice accumulation on power lines and from falling trees and limbs weighted down by ice. Such events could result in the need to repair and replace the infrastructure and lost economic opportunity to benefits; burst water pipes from loss of power to buildings; and the risk of electrocution from downed lines. The Plan emphasizes that tree trimming can decrease the potential for outages resulting from snow and freezing rain.

Additionally, it was noted that 26.8% of the population of St. James are in age categories which are at the greatest risk for heat related illness and death. Between 1999 and 2012, Phelps County experienced 142 days of extreme heat events, many of which continued for multiple days at

temperatures above 100 degrees. Although not mentioned in the Hazard Mitigation Plan, system reliability is crucial to providing air conditioning to these vulnerable populations. Finally, the Hazard Mitigation Plan sets forth Mitigation Actions that can decrease the long-term risk from hazards and their impacts. Those that are applicable to electric utilities include:

- Provide information on tree trimming and dead tree removal programs to utility companies and local government.
- Continue to encourage a self-inspection program at critical facilities to assure that building infrastructure is earthquake and tornado resistant.
- Continue to encourage businesses and public entities to develop and implement emergency plans.
- Encourage the installation of backup generators for critical infrastructure.
- Continue to encourage joint meetings of different organizations/agencies for mitigation related planning.
- Continue to encourage joint training (and drills) between agencies, public and private entities (including schools/businesses).
- Pool different agency resources to achieve widespread mitigation planning results.
- Maintain updated mutual aid agreements between emergency response agencies inside and outside the region.
- Work with State Emergency Management Agency regional coordinator to learn about new mitigation funding opportunities.
- Encourage local jurisdictions to budget for mitigation projects.
- Prioritize mitigation projects, based on cost-effectiveness and starting with those sites facing the greatest threat to life, health and property.

The plan notes that the City of St. James has completed or taken action on all of these Mitigation Actions.

Leveraging Stakeholders, Partners and Community Assets

Stakeholder Engagement – Engage stakeholders early in the resilience planning process.

Stakeholders should be engaged to articulate priorities, assess baseline conditions, refine goals and assist in developing implementation strategies. Successful stakeholder engagement can increase the potential for long-term support and the chances for success.

Leverage Partners and Assets - Convene skills, resources and perspectives.

Leveraging available resources, partners and assets can aid in mitigating critical gaps in funding and expertise, as well as provide a number of additional co-benefits.

St. James has a wide variety of potential stakeholders and partners which can be engaged in its efforts to increase the resilience and reliability of its electric system through its Reliability Improvement Plan. Such engagement can help St. James find new opportunities and take its robust resilience plan to new heights. Stakeholders add their knowledge, experience and perspectives to resilience planning and prioritization. They help inform the plan so it better fits the community's needs and priorities. Stakeholder engagement is particularly important when utility rates may be impacted by resilience activities. By engaging customers representing various rate classes and interests, utilities can better understand the impacts of rate changes and the community's priorities. Partners are those people or entities that bring skills or resources needed for resilience planning and implementation. There is

overlap between the two, but partners provide resources such as funding, personnel, equipment or services necessary for resilience related activities.

Table 5 sets forth a number of potential partners and stakeholders which could be engaged by the City. This is not an exhaustive list and there are certainly other stakeholders and partners that could also be engaged and add value. This table provides the name and description of the entity as well as potential contributions it could make to resilience planning and implementation.

Table 5 Potential Partners and Stakeholders

Name	Description	Contribution	
	City Officials, Staff and Related Entities		
City Administrator	Chief administration officer of the city supervising and coordinating activities of all departments and offices.	City-wide perspective over operations, budget, staffing and other information.	
Public Works Director	Responsible for day-to-day operation and maintenance of the City's infrastructure.	Information regarding operations, staffing, performance, data availability and other matters related to the City's infrastructure.	
City employees' duties directly related to the electric system	Electric Manager, linemen, Municipal Utilities Office Manager, utilities clerks and utilities mechanic.	Working knowledge of the grid, its operations, performance, vulnerabilities and needs. Information and data relating to billing systems, customers, contracts, invoicing and other business-related functions.	
City Mayor	Provides day-to-day guidance to the City Administrator and appoints City Board members, including the Municipal Utilities Board. Responsibilities for City Council meetings include setting agendas, chairing meetings and calling special meetings as needed.	Can provide perspectives relating to community governance and the balancing of City priorities, as well as information regarding community member interactions, complaints and requests. Sets meeting agendas and chairs meetings in which resilience planning and implementation matters may be discussed or acted upon. Can appoint Municipal Utilities Board members that are interested in or have knowledge related to grid modernization and resilience.	
City Council	Council members, as a group, are the legislative and policy making body of the City. The City Council passes ordinances, budgets and policies under which city business is conducted. The City Council confirms Municipal Utilities Board Members and approves rates and charges.	Can provide perspectives relating to community governance and the balancing of City priorities, as well as information regarding community member interactions, complaints and requests. Must pass appropriations and ordinances which may be necessary to implement resilience planning and implementation.	
Municipal Utilities Board	Appointed by the Mayor and confirmed by the City Council, the Board oversees the operations of the Municipal Utilities.	Can provide perspective relating to decisions of the Utilities Board which impact the direction and operation of the electric utility. The Board is reliant upon information provided by City employees to make its decisions. Participation in planning activities, provides the Board information and a knowledge base for future decisions.	
Other City Employees	Includes Code Enforcement, Parks and Recreation, Police Department, Sanitation Department, Streets Department, Public Works and non-Electric Department employees of the Municipal Utilities.	In their daily activities, other employees may observe or become aware of maintenance issues, threats or opportunities to improve the reliability of the electric system or to improve the efficient use of energy in their facilities or activities. Cross training and redundant functionalities that can be useful during emergencies or other stresses on the ability to perform essential functions can be explored.	

Name	Description	Contribution
City Clerk	The City Clerk is the custodian of many city records, issues various licenses, is often the primary point of contact with residents and provides support and coordination to various City officials, departments and staff.	Has access to and knowledge of data that may be useful to assess performance of city facilities; business types and locations; and other information that can be useful in assessing baseline conditions and assessing effectiveness of resilience activities. The Clerk also can provide information regarding complaints, concerns or requests from the public and help identify and secure resources needed for implementation.
Alliance Water	Private company contracted by the City to operate the municipal water and wastewater systems.	Has knowledge of the performance and vulnerabilities of the water and wastewater system, as well as opportunities to increase its energy efficiency and impacts of various grid improvement activities on the water and wastewater systems. Additionally, as a company, Alliance Water may be able to provide leading practices and information regarding their experiences in resilience planning and implementation.
Industrial Development Authority (IDA)	Quasi-governmental entity with the ability to issue tax exempt bonds for construction of industrial facilities, operates the St. James Industrial Park and owns a leased manufacturing facility.	The IDA can provide information regarding the energy needs of existing tenants of the industrial park, as well as those considering the location. They have data relating to the industrial park and its tenants and may be able to identify opportunities to expand the use of distributed energy or implement efficiency measures, microgrid or other resilience applications. The IDA may also be a source of funding, through revenue bonds, of grid improvements benefiting their tenants.
Business Interests		
St. James Chamber of Commerce	Local association to promote the community and its economy, as well as provide networking opportunities and other benefits to its members.	Can provide general perspectives and needs of existing and prospective local businesses to grid radiality issues; identify specific businesses or types of businesses that could benefit from advanced technologies; and act as a conduit for education or information gathering relating to resilience planning and implementation.
Industrial Customers	Local businesses whose facilities and equipment generally use electricity for processing, producing or assembling goods, often for manufacturing.	Can provide information and data relating to energy usage, reliability needs, the impacts of outages or fluctuations and may be willing to participate in programs or pilots relating to efficiency, distributed energy, microgrids or other resilience related opportunities.
Commercial Customers	Generally, local service providers, governments and other non-residential or industrial energy users.	Can provide information and data relating to energy usage, reliability needs, the impacts of outages or fluctuations and may be willing to participate in programs or pilots relating to efficiency, distributed energy, microgrids or other resilience related opportunities.
Missouri Department of Economic Development	State agency primarily responsible for encouraging economic growth in Missouri.	Information relating to energy needs of businesses and industry sectors to assist the community prepare for business attraction and retention. Infrastructure funding opportunities.
Emergency Response		

Name	Description	Contribution
St. James Police Department	Municipal Police Department	As with all emergency response entities, the Police Department can provide emergency response needs/requirements of the grid (reliability, redundant power supply, etc.) as well as impacts of considered improvements; information and data regarding emergency warnings, accidents involving damage to the electric system; and notification of infrastructure concerns, damage in those areas related to law enforcement. Can also provide education and public awareness of resilience efforts/safety, when applicable to its mission, as part of its ongoing public outreach.
St. James Ambulance District	Provides ambulance, EMT and Paramedics to St. James, eastern Phelps County and portions of three adjacent counties.	As with other emergency response entities, the Ambulance district can provide information relating to the needs and requirements of the grid in order to provide ambulance services to St. James and its remaining region.
St. James Fire Protection District	Provides fire protection and emergency response in and around St. James.	As with other emergency response entities, the Fire Protection District can provide information relating to the needs and requirements of the grid in order to provide services and emergency warnings to St. James and its remaining region.
Rolla Police Department	Operates Central Communications Center for Phelps County.	As the operator of the Communications Center for the entire county, the Rolla Police Department can provide information relating to the needs and impacts of grid enhancements and maintenance on communication and coordination of emergency activities and warnings county wide. They will also have data which can be utilized for baseline assessment and measuring performance and to identify opportunities for implementation that could increase the resilience of the communications systems.
	Essential and Hi	igh Loss Facilities
Mercy Medical	Family medicine clinic.	All essential and high loss facilities will have information and data
Forrest City Medical Center	Primary care clinic.	relating to the energy needs of their facilities. This may include the day-
VA Clinic	Outpatient clinic for qualifying veterans and families.	to-day needs, as well as requirements for redundant or backup systems necessary to provide essential services, including those to vulnerable
Missouri Veteran's Home	State run, long-term, skilled nursing facility for Missouri veterans.	populations. These facilities can provide information regarding implementation opportunities, impacts of grid enhancements and data
St. James Living Center	Privately operated long-term, skilled nursing facility.	 that can be used to measure success of implementation activities. Additionally, they may have experience in resilience planning or access to associations, corporate management, governmental entities or others
St. James School District	Provides Kindergarten through 12 grade education for children in St. James and the surrounding area.	with the ability to provide leading practices, case studies or other resources for resilience planning and implementation.

Name	Description	Contribution
Hand in Hand Preschool	Childcare center accepting children from 12 months to age 12.	
St. James Head Start	Development program for children from birth to age 5.	
	Other	Utilities
Ameren	Interconnected, investor-owned electric utility. Interconnected at the Phelps substation, where SJMU takes power.	The two utilities can supply each other with information and regarding their systems which may impact the resilience of the other or both. Such information can include that which is needed for baseline assessment, performance measures and to identify implementation opportunities. Additionally, there may be opportunities for mutual aid, joint trainings and other mutual beneficial activities. Ameren may also be a resource for resilience planning and implementation leading practices.
Rolla Municipal Utilities	Municipal Utility, adjacent to St. James Municipal Utilities.	As a neighboring utility, RMU may provide opportunities for mutual aid, joint trainings and combined purchasing power which could decrease costs to both utilities. RMU may also be a resource for resilience planning and implementation leading practices.
Inter-County Electric	Rural electric cooperative, adjacent to St. James Municipal Utilities. Has under build on some SJMU poles.	As with other adjacent utilities, Inter-County may provide opportunities for mutual aid, joint trainings and combined purchasing power which could decrease costs to both utilities. The cooperative may also be a resource for resilience planning and implementation leading practices. Inter-County would have specific information regarding the impact of resilience measures on its facilities associated with SJMU poles. There may also the potential for the utilities to provide redundancies or interconnections to increase the reliability of both utilities.
CenturyLink	Internet/phone/cable provider. Has facilities collocated on STMU's poles.	Communications providers with facilities located on SJMU poles will have information relating to the impacts of grid resilience measures on
Charter Communications/Spectrum	Internet/phone/cable provider. Has facilities collocated on STMU's poles.	the communications facilities. They could provide information relating to emergency notification and communications transmitted to St. James residents through their facilities and help identify opportunities to strengthen the emergency communication system. Their employees could also provide information to SJMU regarding maintenance issues and threats to the electric grid observed when working on their facilities.
	Associations	Organizations
Meramec Regional Planning Commission (MRPC)	Voluntary council of governments in an eight-county area which includes Phelps County and St. James.	MRPC provides, among many other services, hazard mitigation, emergency and other planning services and coordination; grant writing; and coordination of disaster recovery funding. It can be a source of leading practices within its area as well as those from the other 19 councils of government in Missouri.

Name	Description	Contribution
Missouri Public Utility Alliance	MPUA represents municipal utilities in the state. It is made of up three organizations which provide a variety of services to its members including the administration of the power pool through which St. James receives power.	The MPUA, and its associated entities, provides lineman and other training, technical assistance, power supply and management, financing, outreach and mutual aid services for its members. It is a source of information for leading practices, data and other information.
American Public Power Association (APPA)	National association of public power utilities. It provides advocacy, education and collaboration to its members. St. James uses the APPA's eReliability Tracker to collect and analyze system reliability information.	The APPA can be a source of training, leading practices and data related to system operation and management, resilience/reliability implementation opportunities and progress measurement. It has also funded innovative utility projects relating to increased efficiency, reduce costs, new technologies, new services and improving processes.
	Governme	nt Agencies
Missouri Division of Energy	The state energy office which is a division of the Missouri Department of Natural Resources.	The Division of Energy is a source of information and technical assistance relating to energy efficiency, energy resources, training, measurement, outreach, partnerships and financing opportunities. It provides low-interest financing for energy efficiency and other improvements to reduce energy costs in school and local government buildings.
Missouri State Emergency Management Agency (SEMA)	State agency primarily responsible for preparation and recovery from emergencies.	SEMA is a source for information regarding emergency planning, response and recovery at the local, regional and state level. It provides state coordination activities and assistance. It has information and data relating to risks, assets, mitigation and available resources at the federal, state and local level.
Missouri Department of Natural Resources (MoDNR)	Agency responsible for the air, land, water, mineral and energy resources of the State.	In addition to the resources provided by the Division of Energy, MDNR has information relating to flooding, river levels, sinkholes, geologic mapping and other hazardous. Its Environmental Emergency Response program responds to emergencies relating to hazardous substances. The department also provides financial assistance which can be utilized to increase energy efficiency in water and wastewater facilities.
Missouri Department of Higher Education and Workforce Development	State agency which carries out the goals and administrative responsibilities for the state system of higher education and administers workforce training programs.	Workforce development can help locate training for utility staff and can post jobs to help fill positions with skilled employees.
US Department of Energy	Federal agency responsible for addressing the nation's energy and nuclear challenges through science and technology solutions.	The Department of Energy has a vast amount of data and information relating to energy efficiency, energy resources and technology which can be utilized to develop programs,

Name	Description	Contribution
US Environmental Protection Agency	Federal agency responsible for protecting human health and the environment.	Source of information and tools relating to energy efficiency. Responsible for the Energy Star program, including the Portfolio Manager which can be utilized to benchmark energy performance of City building and facilities.
US Department of Agriculture, Rural Development	Part of the US Department of Agriculture, Rural Development promotes rural economic development.	Provides a variety of funding programs for infrastructure, energy efficiency and distributed energy projects.
Federal Emergency Management Agency	Federal agency responsible for disaster planning and recovery.	Can provide information regarding resources, funding and leading practices relating to emergency planning, response and recovery.
	Non-Governmen	tal Organizations
Midwest Energy Efficiency Alliance	Collaborative network advancing energy efficiency in the Midwest for sustainable economic development and environmental stewardship.	Can provide information and leading practices regarding energy efficiency projects, case studies and provide opportunities to network with other entities.
Renew Missouri	Non-governmental organization dedicated to advancing renewable energy and energy efficiency in the state.	Can provide information and leading practices related to renewable and energy efficiency planning and implementation.
Missouri Energy Initiative	Non-profit association of public and private sector entities created to advance energy economic development, innovation and education.	Can provide PACE financing for energy efficiency and renewable energy projects in commercial applications.
	Other Cor	nmunities
City of Waynesville13	Missouri community of approximately 5,000 residents. It is approximately 38 miles southwest of St. James.	May provide services and equipment under the mutual aid agreement. May also be a source of information and leading practices relating to system management, planning or other areas.
City of St. Robert	Missouri community of approximately 4,500 residents. It is approximately 35 miles southwest of St. James.	May provide services and equipment under the informal mutual aid agreement. May also be a source of information and leading practices relating to system management, planning or other areas.
Other Communities, as needed		Other communities with information and leading practices regarding system management, planning and other resources may be identified.
	Oth	ners
Archer-Elgin Engineering Surveying and Architecture	Consulting engineer utilized by the utility.	Can provide design services for system upgrades, information regarding planning and leading practices from other installations.

¹³ The City of St. James has strong relationships with both the City of Waynesville and the City of St. Roberts. In addition to collaboration between their electric departments, they are familiar with each other's systems, equipment, and capabilities.

Name	Description	Contribution
Brown Tree Service	Right-of-way and easement clearing contractor for St. James Municipal Utilities.	Can provide additional staffing for vegetation management.
State Technical College of Missouri	Technical college, located approximately 40 miles north of St. James providing a variety of programs including their Electrical Distribution Systems Program.	Can provide technical information and training for linemen and be a source of recruitment for employees and interns.
Missouri University of Science and Technology	State university located in Rolla, MO, approximately 11 miles southwest of St. James, MS&T maintains living laboratories utilizing solar and microgrid applications through its Energy Research and Development Center.	Can provide information and data regarding implementation options, leading practices, researching findings.
Mineral Area Community College, St. Louis Community College, Crowder College and other Community Colleges in Missouri	The community college system throughout the state offers associates degrees, certificate programs and training relating to efficiency, solar technologies and other distributed energy programs.	Can provide technical information regarding implementation options, leading practices and be a source for recruitment of employees and interns.
The Electrical Connection	Runs an electrical training/union apprenticeship program for St. Louis and eastern Missouri.	Can provide training opportunities for lineman.
Missouri Clean Energy District	Statewide Property Assessed Clean Energy (PACE) District.	Can provide financing for energy efficiency and renewable energy projects in commercial and industrial applications.

Source: St. James Municipal Utilities RFI Response (2020), AECOM analysis (2020)

Partners

Partnerships allow resilience planning and implementation of the Reliability Improvement Plan to be more comprehensive and effective than could be achieved through an individual effort. Partners bring many resources to the planning or implementation process. The first step in selecting partners is to determine why they are needed. By looking at the reliability and resilience goals, available resources, weaknesses and known opportunities, St. James can identify area in which partners could be beneficial. In the area of reliability improvement, partners with technical knowledge or experience and funding could play significant roles and help achieve progress toward the utility's goals.

Partners often fit into one of five resource categories. Table 6 describes those categories and lists a few of the entity types that could be looked to as potential partners for St. James.

Table 6 Partner Categories

Partner Resource Category	Description	Types of Partners
Experience	Stakeholders or partners that have significant experience or knowledge in an area: • System Design • Hazard Mitigation Planning • Microgrid Application	Other utilities, government officials, engineers, Councils of Government
Information and Data	Holders of data, records, or other information: • Budget Information • System Outage Analytics • Economic Impact of Outages	State, county, or city agencies, customers, associations
Staffing	Those with personnel to assist with or carry out an activity: Training Mutual Aid Tree Trimming Consultants	Utility associations, neighboring communities, civic organizations, local businesses and learning institutions (including those with the ability to provide intern labor)
Physical Assets	Those with equipment or facilities: • Mutual Aid • Meeting Space	Local businesses, emergency response agencies, other utilities
Funders	Entities that can provide financial resources	Federal and state agencies, foundations, other city departments

Source: Roadmap to Resilience (2020), AECOM analysis (2020)

These categories are not the only resources a partner might supply. As can be seen in the table of potential partners (Table 5), the community and subject matter afford a wide variety of partnership opportunities that can be applied strategically to meet the grid modernization goals and needs of St. James Municipal Utilities.

To continue to move their goals forward, St. James can develop key criteria for partner engagement and use that to screen those in Table 5 and others for the most impactful potential partners and stakeholders. It is often beneficial to select partners that can provide value throughout the process in multiple areas. For example, a utility's goal in piloting a distributed energy application may be to collect data on its impacts to the system and to understand changes in energy use. The benefits in piloting a DER application to the partnering manufacturer may be reduced energy costs and fewer process disruptions due to power outages. Partners that understand both goals and their own benefits are more likely to stay committed to the project and fulfill their roles.

Assets

St. James has several unique assets that place it in a position to further its community resilience goals. Leveraging these assets will enable the city to implement important initiatives and continue to identify areas in which to improve resilience. These assets are listed and described below.

Forward-looking vision

Prior to 2016, it had been years since St. James had engaged in any proactive maintenance. Up until then, the maintenance strategy had been to repair what was broken, with little allocation for any routine maintenance or replacement scheduled. Upon arrival of a new city administrator in 2016, an aggressive forward-looking vision for proactive maintenance began to take shape. The vision included beginning to set money aside for preventative maintenance, repairs and replacements. It also included evaluating initiatives to optimize the impact of spent resources, which included focusing on primary distribution lines and undergrounding secondary lines. This vision resulted in the Reliability Improvement Plan, which the City continues to use to guide much of its maintenance work.

Innovative funding strategies

Innovative funding strategies can be a key asset in implementing resilience actions, particularly for SMSC with resource constraints. In order to fund the vision of proactive grid maintenance, St. James implemented unique funding strategies. Essentially, they quantified their asset depreciation and put it towards system upgrades and maintenance. They amounted to approximately \$300,000 annually, with the goal of doing such for at least five subsequent years.

Supportive local government

The St. James Municipal Utilities (SJMU) was founded in 1947 as a city-owned service, operating under the leadership of the St. James Municipal Utilities Board which is comprised of four members appointed by the Mayor and confirmed by the City Council. Together, they provide guidance and leadership for utility actions. The supportive structure of the Municipal Utilities Board enabled the utility to begin implementing the proactive maintenance included in its forward-looking vision as well as articulate the innovative funding strategies to support the necessary actions. Such a partnership is key to advancing resilience actions within SMSC.

Industrial and commercial strengths

Despite the percentage of unemployment/out of the workforce, St. James has significant industrial and commercial assets located within the community that support the population. More than 80% of the

community workforce is employed by private businesses. The City's primary employment sectors are education, healthcare and social service and singularly employ 20% of the local workforce. Other major local employers include the Wal-Mart Distribution Center, which employs more than 750 employees, the St. James School District, which employs more than 230 individuals, as well as Tacony and Cohen Architectural Woodworking, each of which have more than 70 employees. The diversified economic base offers a number of partnership opportunities that can be leveraged to advance specific initiatives. Additionally, the fact that St. James does not rely on a single type of employer is promising for future economic growth and opportunity.

Advanced Metering Infrastructure Network

AMI networks are a significant asset to the electric grid and can offer multiple benefits. These benefits include improving grid operations, contributing towards energy efficiency, enabling data capture and providing opportunities for grid and load optimization. Currently, St. James collects usage data from their AMI network, but to date, there are still opportunities to leverage the network for additional data information such as demand response and outages, to further optimize system efficiency and improve reliability. This existing network of smart meters can also be used as a way to enable customer education regarding energy efficiency and provide greater customer control over usage.

St. James Goals and Targets

The City of St. James has identified the following key goals and targets to be advanced through application of the *Roadmap*:

- Pole Replacement: St. James has committed to replacing 100 poles annually.
- Introducing Skill Development Programs: Interest has been expressed in developing job training and skill enhancement programs. The programs would result in substation certification that would expand the skill sets of workers and provide greater employment opportunities and job training. The program is still in early conceptual phases. Empowering local community members with the skills needed to effectively execute job needs is a critical piece of improving community resilience.
- Reliability: SJMU's Reliability Improvement Plan, while critical in advancing grid maintenance within St. James, does not include specific reliability goals and targets. As part of the application of the *Roadmap*, SJMU has determined that it would benefit from additional goals against which to measure their progress and outcomes. In that vein, it is recommended that, within the next five years, St. James meet specific SAIDI, SAIFI and CAIDI goals falling within a range designed to be achievable for a utility of its size and which provide significant reliability improvement. These ranges are indicated below:
 - System Average Interruption Duration Index (SAIDI)
 - Target Range: 152.68 to 137.41 minutes¹⁴
 - System Average Interruption Frequency Index (SAIFI)
 - Target Range: 1.29 to 1.16 minutes¹⁵
 - Customer Average Interruption Duration Index (CAIDI)
 - Target Range: 113.76 to 111.416 minutes¹⁶

¹⁴ The SAIDI target range is between the average 2019 performance of similarly sized utilities that use the EReliability Tracker and 10% better than that average. *Annual Benchmarking Report: eReliability Tracker*. <a href="mailto:mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mccharge-mcch

¹⁵ The SAIFI target range is between the average 2019 performance of similarly sized utilities that use the EReliability Tracker and 10% better than that average. *Annual Benchmarking Report: eReliability Tracker*. mcphersonpower.com/wp-content/uploads/2020/04/2019-APPA-Annual-Benchmarking-Report-eReliability-Tracker-002.pdf.

¹⁶ SJMU currently performs significantly better than the average CAIDI of similarly sized utilities, therefore the target range represents a performance improvement between 3% and 5% from the Utility's 2019 CAIDI.

Innovative Opportunities

St. James' forward-looking vision has set it on the path to securing a more resilient future for its community through proactive grid maintenance efforts. The City's other assets – innovative funding strategies, supportive local government, industrial and commercial strengths and AMI network – create innovative opportunities for St. James to take their electrical grid enhancement efforts beyond their current vision. To build on the opportunities for effective grid maintenance outlined in the Proactive Grid Maintenance and Connection to Resilience section of this case study, St. James might consider the innovative opportunities below.

Leverage AMI to defer electrical grid investments

The existence of a robust AMI network is one of St. James' greatest assets, providing them with valuable energy usage data. However, St. James' AMI network is currently under leveraged. St. James has the opportunity to collect, measure and analyze energy usage in order to identify innovative opportunities to improve grid operations, increase energy efficiency, shorten and decrease outages and enable demand response. By leveraging AMI to reduce energy usage and reduce demand, St. James has the opportunity to optimize electrical grid system efficiency and improve reliability. As a result of decreased stress on transmission and distribution infrastructure, investment in upgrades and repairs will be avoided.

Pilot Distributed Energy Resources

Distributed Energy Resources (DERs) are energy resources that either reduce or shift energy demand, resulting in lower greenhouse gas emissions, reduced peak demand and improved grid efficiency and operations. DERs include but are not limited to solar photovoltaics (PV), energy storage, microgrids, demand response and energy efficiency. By deploying DERs, utilities delay or defer investment in transmission and distribution replacements and repairs. This process is known as a non-wires solution. St. James can initiate DER deployment through innovative pilots that fit the needs of the community.

Invest in energy efficiency for resilience and reliability

Energy efficiency is the least costly DER, and investments in energy efficiency can yield significant returns for both the utility and its customers. Such investments can not only reduce negative grid impacts, but also strengthen the profitability of employers benefiting the local economy.

Energy savings and demand reductions, realized through energy efficiency applications, can displace energy generation from supply-side resources and reduce stress on the grid, ultimately resulting in increased resilience, reduced energy burden and deferred investments in grid infrastructure repair and replacement. Energy efficiency measures can include building retrofits and reducing losses in supply systems. There a broad range of financing options available to support utilities that include budget financing, leveraging revolving funds, public sector financing mechanisms and commercial financing such as bank loans. To strengthen the case for investment in energy efficiency, St. James can partner with local stakeholders to conduct a cost-benefit analysis to examine possible savings associated with electrical grid infrastructure, critical facilities and services, economic development, public health and other categories.

Identify Innovative Funding Sources

Offset resilience initiative costs.

SMSC often face increased funding barriers and leveraging funding sources can play a critical role in determining whether plans can be implemented.

Existing Funding Sources

Funding for system upgrades and maintenance is currently derived from its user charges described in the Conduct Baseline Assessment section. During Fiscal Year 2019, the system collected approximately \$6.3 million in user charges and late fees from its customers. Revenues were utilized to purchase power, pay personnel and professional fees and for operating expenses. During that fiscal year, the utility had \$738,000 more in revenues than expenses.

As part of its Reliability Improvement Plan, the utility is using an amount approximately equal to its depreciation expense for proactive maintenance and upgrades to the system. In Fiscal Year 2019, the depreciation expense was \$300,543. The additional funds used for maintenance and upgrades are used for operational and personal service expenses. By budgeting for system maintenance and upgrades in this manner, the City has increased its operational and personal services expenditures by \$320,432 as compared to Fiscal Year 2015. This is an increase in operational expenditures of 164% and personal service expenses by 36%.

The City has also used General Obligation Bonds to fund system acquisition and upgrades. As described in the Baseline Conditions section, in 2011 the City issued \$6.7 Million to acquire and upgrade the Phelps Substation. Those bonds will be fully repaid and retired in 2030.

Potential Funding Sources

St. James has already enlisted an innovative funding strategy to support system upgrades and maintenance through rate charges, municipal bonds and dedicating funds equal to its depreciation expense. To fund additional proactive grid maintenance efforts and possible innovative opportunities, St. James can leverage grants, financing options, incentives, or public-private partnerships to expand their financial bandwidth and overcome the financial barrier to resilience that many SMSC experience. As outlined in the Proactive Grid Maintenance and Connection to Resilience section of this case study, St. James has the opportunity to implement the following proactive grid maintenance efforts:

- Proactive repair and replacement
- Ensuring redundancy
- Leverage AMI network
- Hardening infrastructure
- Advance energy efficiency efforts

Through these efforts, St. James has the opportunity to achieve the following outcomes:

- Improve reliability through energy efficiency and demand side management programs
- Protect critical assets
- Advance positive business impacts
- Enable emergency response

Below are a set of exemplary programs and funding strategies to support these efforts. These programs build on the possible proactive grid maintenance efforts identified and can contribute to the outcomes listed above. Note that funding opportunities and timelines change overtime as new funding opportunities are introduced and application cycles elapse.

Leverage energy efficiency for energy savings and health benefits.

The United State Department of Agriculture offers a number of grants targeted for rural communities with less than 20,000 residents. Included in this suite of SMSC funding opportunities is the Community Facilities Direct Loan and Grant Program, which provides grants, low-interest direct loans, or a

combination of the two to enhance essential community facilities. ¹⁷ The St. James Living Center, St. James School District and Hand in Hand Preschool are Essential and provide critical services to vulnerable populations such as the elderly and youth (Table 5). Energy efficiency measures can lead to health benefits that are particularly beneficial for vulnerable communities (Figure 4). 18 An additional benefit not listed in the figure below is that increased ventilation in nursing homes and schools may lead to a decreased chance of spreading airborne viruses among vulnerable populations in closed air facilities.

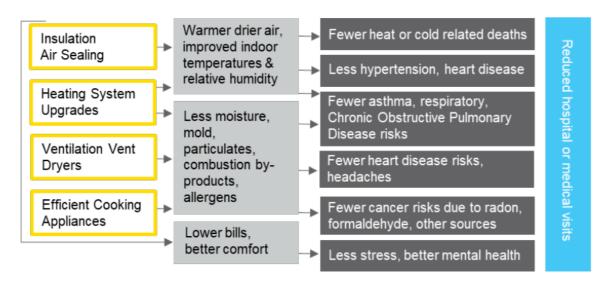


Figure 4 Energy Efficiency Measures and Positive Health Outcomes

Source: Vermont Energy Investment Corporation (2019)

Additionally, increased energy efficiency reduces demand and decreases stress on the grid. The City may be able to avoid repairs or upgrades to transmission and distribution infrastructure through deep energy savings and reduced peak load.

As a public body, the City of St. James would be eligible to apply for the Community Facilities Direct Loan and Grant Program. However, if the City would like to engage an entity with expertise in health or energy efficiency, they could partner with a number of non-profit organizations, which are also eligible to apply, listed in Table 5. These potential partners might include the Missouri Energy Initiative, Renew Missouri and Midwest Energy Efficiency Alliance.

Leverage energy efficiency to redirect municipal funds from energy bills to community projects.

The Missouri Division of Energy offers an Energy Loan Program that provides low-interest loans for energy-saving investments in energy efficiency measures and renewable energy systems. 19 These loans are repaid using the savings realized from the energy savings measures installed. Local government organizations, including municipally owned utilities, hospitals, zoological parks and museums, are eligible applicants. If awarded, St. James would have the opportunity to implement energy saving measures in municipal facilities without using taxpayer dollars to fund improvements. The City could also invest dollars saved on energy bills on community plans and initiatives.

Harden, repair and replace infrastructure.

¹⁷ U.S. Department of Agriculture. Community Facilities Direct Loan and Grant Program. rd.usda.gov/programs-services/communityfacilities-direct-loan-grant-program.

Vermont Energy Investment Corporation (2019). Energy-Plus-Health Playbook. e4thefuture.org/wp-content/uploads/2019/07/Energy-Plus-Health-Playbook VEIC.pdf.

Missouri Department of Natural Resources (2020). Energy Loan Program. dnr.mo.gov/pubs/pub1222.htm.

The Missouri Department of Economic Development offers a Community Development Block Grant program focused on industrial infrastructure.²⁰ Through this program, local Missouri governments are eligible to apply for grant funds to develop or enhance municipally owned public infrastructure that benefits local businesses. Infrastructure hardening investments might include replacing wooden poles with concrete or undergrounding power lines and investments in repairs and replacements involving making necessary upgrades where needed, preferably in a proactive manner. By proactively maintaining and repairing infrastructure, St. James will save additional funds by avoiding costs required to replace infrastructure.

Innovation-focused grants.

As energy efficiency technology becomes increasingly important, funding opportunities that focus on enabling applicants to introduce innovative technologies to their communities are becoming more readily available. An example of such funding are the grants provided by the American Public Power Association. The grants, generally between \$25,000 and \$50,000, but can be as much as \$125,000, are available to its Demonstration of Energy and Efficiency Developments (DEED) program members. The DEED program funding is available for pilots, new technology demonstration and early commercialization projects. The grants are intended to support innovation and research that is transferable and leads to the betterment of public utilities and their customers.²¹

The program also includes the DEED Idea Exchange as a way to support innovative idea with additional funding. Ideas are submitted by DEED members and shared with corporate members to provide more opportunities for funding and partnerships.

St. James can leverage such funding opportunities to introduce measures that increase municipal utility resilience and efficiency. They can also develop partnerships with local businesses to advance community resilience efforts. Examples of eligible initiatives could include microgrids, distributed They can also introduce initiatives focused on advancing energy efficiency or further developing out use cases for the utilities AMI network.

Use Federal and National Lab Resources

Support projects and initiatives.

Federal agencies and national laboratories, such as USDOE, FEMA and the EPA provide several quantitative and qualitative tools that can be leveraged for resilience planning and support projects

A multitude of online quantitative and qualitative resilience planning tools are available for local planners to leverage in their resilience efforts. Many tools are offered by Federal Agencies and National Labs and are supported by case studies demonstrating their usefulness in various applications. Below are descriptions of how St. James resilience leaders can leverage both quantitative and qualitative tools to advance proactive electrical grid maintenance efforts.

Quantitative Tool: Technical Resilience Navigator

The USDOE developed the Technical Resilience Navigator (TRN) tool through their Federal Energy Management Program (FEMP).²² This tool enables organizations to identify energy- and water-related resilience gaps in order to develop practical solutions. Through a five-module process, the tool guides users through two to five actions in each module. Worksheets and resources are provided for project

²⁰ Missouri Department of Economic Development (2020). CDBG Program, Industrial Infrastructure Grant. ded.mo.gov/sites/default/files/programs/flyers/IndInfraGrant ProgSum 2016.pdf.

²¹ American Public Power Association (2020). DEED Funding for Utilities. publicpower.org/deed-funding-utilities.

²² Federal Energy Management Program. *Technical Resilience Navigator*. trn.pnnl.gov/.

team members to leverage in order to complete each module and carry out a thorough and comprehensive planning process (Figure 5).

Figure 5 Inputs, Outputs, Worksheets and Resources for Establishing Baseline Conditions of Energy and Water Systems

♣ Data Inputs Needed

- Existing redundant systems and design attributes
- Redundant system engineering and process flow diagrams
- Redundant system O&M procedures, schedules, and logs
- Past efficiency assessments of facilities with critical loads
- Energy and water supply infrastructure diagrams and condition assessments
- Daily energy and water load estimates (output from Action 2)
- Primary supply system one-line diagrams and condition assessments

1 Outputs of This Action

- Redundant system characteristics required to model risk in the Risk Assessment: Action 3
- · Primary energy and water supply system conditions
- Dependency mapping between critical loads and primary energy and water supply systems
- Existing redundant system runtime duration relative to mission requirements

Source: Federal Energy Management Program, Technical Resilience Navigator

St. James resilience planners can leverage the TRN²³ to identify energy resilience gaps at emergency response facilities such as the police department, ambulance district and fire protection district as well as essential and high loss facilities such as local medical centers, veterans and retirement homes and schools. Through five presented modules, planners can carry out essential functions such as identifying core planning team members and stakeholders, identifying resilience planning priorities and scope, collecting relevant information, conducting baseline assessments, conducting risk assessments and developing and prioritizing solutions.

Qualitative Tool: State and Local Solution Center

Resilience planning is a multistep process and is rapidly increasing in importance. From engaging stakeholders to measuring success, resilience planning responsibilities are multifaceted and wide reaching. As SMSCs across the U.S. experience chronic stress and acute shocks and leaders at the local, state and national levels set goals with deadlines of 5-30 years, resilience planning is becoming increasingly important and tools are constantly being developed with up-to-date research, leading practices and science to support such planning. USDOE's State and Local Solution Center provides resilience planners a collection of resources with guidance for public-sector leaders to invest in energy system improvements.²⁴ The resources in this solution database are categorized into four actions: develop plans and programs, empower organizations, establish financing and implement data management. St. James project leads could leverage the database to dive deeper into processes to support efforts in each of the *Roadmap* actions or to support or follow up on actions or possible solutions from outputs of quantitative tools such as the TRN.

Measure Success

Define metrics and performance indicators early in resilience planning.

Consistent measures to monitor progress enable communities to effectively demonstrate progress and accountability, promote continuous improvement and make forward-looking decisions and investments.

Performance metrics allow a community to evaluate the benefits of efforts and investments through monitoring progress toward specific targets. Consistent measurement enables demonstration of

²³ Federal Energy Management Program. *Technical Resilience Navigator*. trn.pnnl.gov/.

²⁴ U.S. Department of Energy. State and Local Solution Center. energy.gov/eere/slsc/state-and-local-solution-center.

progress, provides accountability, promotes continued improvement and allows strategic and data driven decision making. Publishing or reporting measurements not only increases transparency with stakeholders, partners and community members, it can also serve as a basis to obtain funding for additional investment and support for continued or new initiatives.

As described in the baseline assessment, St. James currently tracks its performance through the APPA's eReliability Tracker. Metrics provided through the system include SAIDI, SAIFI, CAIDI and service availability, all of which directly tie to system outages.

These reliability indices are important to understand a system's reliability performance generally; however, to help drive continued improvement, target performance levels should be set based upon past performance, needs, resources, community priorities and goals. The City has goals for the Reliability Improvement Plan; it has not, however, set specific targets toward which it can show progress. By holistically looking at specific target performance levels and reliability indices, the City should be able to obtain a satisfactory resilience assessment.

While reliability metrics should be tracked annually, given the long-term nature of capital investment and improvements, the target may be to achieve a certain level of performance after a period of years. Annual tracking will allow the utility to understand if it is on track or if adjustments need to be made to achieve the ultimate target.

Other potential metrics can help keep the utility on track or measure activities that should, ultimately, increase the reliability measures described above. Mitigation of risks, increased mapping, budgeting for reliability improvements and other activities are performed to increase reliability. By measuring performance in these areas, the City will be better informed of the underlying reasons for reliability performance.

As described more fully in Table 7, potential metrics to measure the performance of SJMU's Reliability Improvement Plan include:

- System Vulnerability Assessment
- Mitigation of Common System Risks and Threats
- Utility Service Reliability (SAIDI)
- Reduction of Service Outages (SAIFI)
- Customer Average Interruption Duration (CAIDI)
- System Personnel Redundancy
- Distribution System Redundancy
- Mapped Distribution Infrastructure
- Budgeting for Reliability and Resilience
- Reliability and Resilience Expenditures
- Redundant Sources of Electricity for Critical Facilities
- Energy Usage in City Facilities After Installation of Energy Efficiency Measures
- Economic Impact of Power Outages

Data sources are already available for most of the potential metrics set forth below, although much of it is not currently being utilized to measure performance. Data being uploaded to the eReliability Tracker will continue to provide measurement of reliability (SAIDI, SAIFI and CAIDI). The work order tracking system and its recent addition of expenditure amounts, will provide data necessary to measure threat mitigation, and Reliability Improvement Plan expenditures, as will the utility's financial statements. Records are maintained regarding system redundancy and mapping. The AMI system will provide information regarding usage to measure the impacts of efficiency and outage duration. The largest data gap is that related to the economic impact of service outages. To obtain that information, the utility will need to partner with selected customers.

The metrics below are amongst those that can be utilized by the utility to monitor the progress of its Reliability Improvement Plan and resilience activities. Any metrics adopted should be revisited regularly to determine if they are useful in measuring and driving performance. If not, the utility should look for ways to improve its usefulness or adopt a different metric that provides the community better information.

Table 7 Potential Metrics for St. James

#	Metric	Target	How and When Measured	Data Sources Needed	Why Important
1	System Vulnerability Assessment	Conduct a system vulnerability assessment to identify common and infrequent risks.	Completion of system vulnerability assessment. Measured every 2-4 Years.	Work order tracking system and outage cause information in the eReliability Tracker or other utility records.	To provide a mechanism to prioritize resources and address risks to the system in a routine, deliberate manner. Measuring will help ensure that the Reliability Improvement Plan continues as utility and city personnel change.
2	Mitigation of Common System Risks and Threats	Meet target percentage of common system risks mitigated.	Number of identified common risks and threats that are mitigated divided by total common risks identified. Compare to target. = ['sum of identified common risks and threats mitigated']/ ['sum of common risks and threats identified'] Measured every 2-4 Years.	Work order tracking system.	Mitigation of risk can lead to fewer power outages and disruptions.
3	Utility Service Reliability	Reduction of Sustained Average Interruption Duration Index (SAIDI) for All Customers.	Calculate SAIDI for all customers. SAIDI is defined as: Total number of customer-minutes of interruption divided by the total number of customers served for the measurement period. Compare to previous year. = ['sum of customer-minutes of interruption']/ ['sum of customers	Utility outage reports (including outage times, dates and customer numbers) for measurement period and previous year as entered the eReliability Tracker. SJMU can calculate SAIDI itself or rely upon the analysis provided in the Annual Benchmarking Report provided by the APPA.	Outages result in communication, water and transportation disruptions; economic losses due to businesses and production closures, unavailability of goods and services; and exposure to extreme temperatures. Extended disruptions result in greater losses including citizen health and wellbeing implications.

			served']		
			Measured annually.		
4	Reduction of Service Outages	Reduction of System Average Interruption Frequency Index (SAIFI) for All Customers.	Calculate SAIFI. SAIFI is defined as: Total customer interruptions divided by the total number of customers for the measurement period. Compare to previous year. = ['sum of customer interruptions']/ ['sum of customers']	Utility outage reports (including number of interruptions and customers) for measurement period and previous year as entered the eReliability Tracker. SJMU can calculate SAIFI itself or continue to rely upon the analysis provided in the Annual	Outages result in communication, water and transportation disruptions; economic losses due to businesses and production closures, unavailability of goods and services; and exposure to extreme temperatures. Extended disruptions result in greater losses.
			Measured annually.	Benchmarking Report provided by the APPA.	

5	Customer Average Interruption Duration Index (CAIDI)	Reduce the average outage duration over a 10-year period.	Measure the average interruption duration that any interrupted customer would experience by dividing the total duration of sustained interruptions in a year by the total number of interruptions. Sustained interruptions are defined as those lasting 5 minutes or more. CAIDI is also seen as the average restoration time. CAIDI = SAIDI/SAIFI. Compare to baseline period. = ['sum of minutes of sustained interruptions']/ ['sum of interruption incidents'] Measured annually.	Utility outage reports (including outage times and number of incidents) for measurement and baseline periods. SJMU can calculate SAIFI itself or continue to rely upon the analysis provided in the Annual Benchmarking Report provided by the APPA.	Outages result in communication, water and transportation disruptions; economic losses due to businesses and production closures, unavailability of goods and services; and exposure to extreme temperatures. Extended disruptions result in greater losses.
6	System Personnel Redundancy	Meet target redundancy in all essential utility operational areas.	The number of trained, certified or qualified personnel available or under contract (mutual aid agreement, emergency contract, etc.) and in the region, for each essential function. Measured annually.	The number of certified or qualified personnel available or under contract. Data from utility system personnel records and other contracting parties.	The availability of redundant, qualified personnel will ensure continuation of essential functions in the case of an unavailable personnel. Will also enhance transfer of knowledge.

7	Distribution System Redundancy	Meet target percentage of energy demand on redundant distribution systems.	Energy demand on redundant (parallel feeders, ring main feeders, or other systems that allow continuous supply in case of line fault) distribution systems divided by the total demand. Compare to target. = ['sum of energy demand served by redundant distribution system']/ ['sum of energy demand'] Measured annually.	Distribution network profile and energy demand from utility system records.	To limit number and duration of power outages.
8	Mapped Distribution Infrastructure	Increased percentage of distribution infrastructure assets with GIS mapping until 100% is attained.	Number of distribution infrastructure assets with GIS mapping divided by number of infrastructure assets. Compare to previous year. = ['sum of assets with GIS mapping']/ ['sum of assets'] Measured annually.	Distribution infrastructure Inventory and GIS mapping for measurement period and previous year.	The ability to locate distribution infrastructure assets will provide for faster response in case of infrastructure failure and ensure up-to-date records.
9	Budgeting for Reliability and Resilience	Increase budgeted amounts for system maintenance and upgrade planning and implementation.	Difference between the dollar amount budgeted for system maintenance and upgrades during the measurement period and that of baseline period. Measured annually.	Utility budget and backup detail regarding system upgrades and maintenance for the measurement and baseline periods.	Available funding for capital improvements related to system maintenance and upgrades lead to increased activity and indicate support for implementation.

10	Reliability and Resilience Expenditures	Target percentage of budgeted resilience plans spent or committed.	Amount of budgeted system maintenance and upgrade funds spent or committed (project/activity under contract or underway) divided by the total amount of funds budgeted for resilience. Percent compared to target. = ['sum of resilience funds spent or committed during budget year']/ ['sum of resilience funds budgeted'] Measured annually.	Community budget and backup detail regarding system maintenance and upgrade and expenditure amounts for those budgeted items.	Indicates progress toward Reliability Improvement Plan activities.
11	Redundant Sources of Electricity for Critical Facilities	Target percentage of critical infrastructure assets with alternative, independent power source.	Number of critical facility assets divided by the number with alternative, independent power sources. If uninterrupted power supply is used, it must be capable of providing power for 8 hours. Compare to target. = ['sum of critical infrastructure assets with alternative, independent power sources']/ ['sum of critical infrastructure assets'] Measured annually.	Number of critical facility assets and number with redundant sources of electricity. Available from local emergency management agency records or survey of owners or operators of critical facility assets.	To ensure that critical facility assets such as hospitals, water systems and communication centers can perform in case of primary power supply loss.

12	Energy Usage in City Facilities After Installation of Energy Efficiency Measures	Reduction of energy usage in city facilities.	Compare amount of energy used during baseline period prior to installation of energy efficiency measures to that during measurement period. To normalize for weather between baseline and measurement years in buildings that are heated or cooled, divide kWh used during baseline period by total heating and cooling degree days for the same period. Compare to kWh used during measurement period divided by total degree days for the measurement period. = ['sum kWh used in facility']/ ['sum of heating and cooling degree days'] Measured annually.	Energy usage during baseline period and during measurement period after installation provided by the facility owner or operator. Degree days for the baseline and measurement periods. Degree day calculator: https://portfoliomanag er.energystar.gov/pm/degreeDaysCalculator	Potential for positive budget impacts. City provides leadership and example to the community.
13	Economic Impact of Power Outages	Reduce the quantifiable impact of system power outages.	Comparison of economic impact of power outages to selected customers during baseline to that of the measurement period. Measured annually	Duration of power outages during baseline and measurement periods from utility (SAIDI and SAIFI numbers) obtained from electric utility. Economic activity figures from selected customers based upon process down time and any resulting repair or maintenance costs.	Power outages result in loss of revenue and productivity.

Conclusion

St. James, through its foresight and implementation of its Reliability Improvement Plan, has made significant progress toward its resilience and reliability goals. It has also laid a strong foundation to continue their grid enhancement efforts and to move them beyond their current vision. By applying the actions set forth in the *Roadmap*, the community can leverage its assets to identify additional opportunities and priorities which could include more fully utilizing its AMI resources, piloting distributed energy applications and investing in energy efficiency. In doing so, the community can become even more resilient and see additional positive outcomes in the areas of reliability, protection of critical assets, reduction of energy burden and business profitability.

Findings and Lessons Learned

The experiences and efforts of the City of St. James in replacing its aging electric infrastructure and engaging in proactive and protective grid maintenance have led to the following findings and lessons learned:

- Resilience of electric systems is vital for protecting critical services for vulnerable populations.
- Deferred maintenance has had significant impacts on the condition of existing critical infrastructure.
- Supportive local government can be instrumental in pushing forward proactive goals.
- Innovative funding strategies can be used to cover costs for system upgrades and maintenance.
- Effective resilience plans can vary in level of formality.
- Plan implementation can be strengthened by setting measurable performance targets.
- Energy efficiency can be a keyway to reduce load on grid systems, extending lifetime and decreasing maintenance needs. These findings and the actions that St. James has taken, can serve other SMSCs as replicable strategies to overcome challenges and constraints experienced by smaller communities in resilience planning and implementation. Further, the components of this case study can be incorporated into St. James' existing planning efforts to support implementation efforts and inform long-term grid strategy.

Acronyms

AMI Advanced Metering Infrastructure
APPA American Public Power Association
ASAI Average Service Availability Index

CAIDI Customer Average Interruption Duration Index

DEED Demonstration of Energy and Efficiency Developments

DER Distributed Energy Resource
EPA Environmental Protection Agency
FEMP Federal Energy Management Program
IDA Industrial Development Authority

LCOE Levelized Cost of Energy

MoDNR Missouri Department of Natural Resources

MoPEP Missouri Public Energy Pool

MRPC Meramec Regional Planning Commission

PACE Property Assessed Clean Energy

PILOT Payment in Lieu of Taxes

PV Photovoltaic

SAIDI System Average Interruption Duration Index
SAIFI System Average Interruption Frequency Index
SEMA Missouri State Emergency Management Agency

SJMU St. James Municipal Utility

SMSC Small- to medium- size community
TRN Technical Resilience Navigator
USDOE United States Department of Energy

